3D Camcorder Project Using Libre Computer Renegade

Assembled by: Mike Young – Nov. 22, 2023 Last updated on Jun. 11, 2025

Image a SD card with the Raspbian Lite image from Libre Computer...

Website for the Renegade:

https://libre.computer/products/roc-rk3328-cc/

Link to Raspbian images: https://distro.libre.computer/ci/raspbian/

Specific image used:

https://distro.libre.computer/ci/raspbian/11/2023-05-03-raspbian-bullseye-arm64-lite%2Barm64.img.xz

Extract the .xz file using 7-zip and image the SD card using Win32DiskImager.

Insert the SD card in the Renegade and boot it up.

Create user...

Username: user Password: password

Run...

```
sudo raspi-config
```

...and configure the system for automatic login to the terminal and enable SSH.

Make sure the system is connected to the Internet and install FFmpeg, gpiod, libgpiod-dev, exfat-fuse, and exfat-utils...

```
sudo apt update
sudo apt install ffmpeg
sudo apt install gpiod libgpiod-dev
sudo apt-get install exfat-fuse exfat-utils
```

Run...

hostname -i

That will indicate the IP address of the unit. Note the IP address and connect to the system using PuTTY.

Run...

nano ~/.nanorc ...and add this line to the end of that file...

set tabsize 4

...and save that file by pressing [Ctrl] + [X], [Y], and [Enter].

Run this command...

nano ~/.profile

...and add the following lines to the bottom of that file...

...then save that file by pressing [Ctrl] + [X], [Y], and [Enter].

Create a mount point and give it needed permissions with the following commands...

```
sudo mkdir /mnt/usb
sudo chmod 777 /mnt/usb
```

Run this command to open cam.c for editing...

nano cam.c

...and paste the following code into that file...

Link to latest cam.c source code, version 16

...then save that file by pressing [Ctrl] + [X], [Y], and [Enter].

Compile that C program with the following command...

gcc -o cam camX.c -lgpiod

...where X is the version of the source code file (the latest version is 16). That command will compile cam X.c into executable file cam, which is configured to launch upon auto-login.

| | | | 40 Pin Header J1 | | | | | | |
|------|---------|-------|------------------|-------|-------|---------|------|------------|--------------|
| GPIO | | | IR/SD/LED Side | | GPIO | | | | |
| Chip | Linux # | sysfs | Row 1 | Row 2 | sysfs | Linux # | Chip | | |
| 3.3V | 3.3V | 3.3V | 1 | 2 | 5V | 5V | 5V | D | |
| 2 | 25 | 89 | 3 | 4 | 5V | 5V | 5V | Power Oπ: | GPIO 3 / 25 |
| 2 | 24 | 88 | 5 | 6 | GND | GND | GND | Start Rec: | GPIO 13 / 21 |
| 1 | 28 | 60 | 7 | 8 | 100 | 4 | 3 | Stop Rec: | GPIO 11 / 20 |
| GND | GND | GND | 9 | 10 | 102 | 6 | 3 | = GND: | GPIO 6 |
| 2 | 20 | 84 | 11 | 12 | 70 | 6 | 2 | | |
| 2 | 21 | 85 | 13 | 14 | GND | GND | GND | | |
| 2 | 22 | 86 | 15 | 16 | 103 | 7 | 3 | | |
| GND | GND | GND | 17 | 18 | 101 | 5 | 3 | | |
| 3 | 1 | 97 | 19 | 20 | GND | GND | GND | | |
| 3 | 2 | 98 | 21 | 22 | 2 | 2 | 0 | | |
| 3 | 0 | 96 | 23 | 24 | 104 | 8 | 3 | | |
| GND | GND | GND | 25 | 26 | 76 | 12 | 2 | | |
| 2 | 4 | 68 | 27 | 28 | 69 | 5 | 2 | | |
| 2 | 19 | 83 | 29 | 30 | GND | GND | GND | | |
| 2 | 23 | 87 | 31 | 32 | 0 | 0 | 0 | | |
| 2 | 16 | 80 | 33 | 34 | GND | GND | GND | | |
| 2 | 18 | 82 | 35 | 36 | 64 | 0 | 2 | | |
| 2 | 15 | 79 | 37 | 38 | 65 | 1 | 2 | | |
| GND | GND | GND | 39 | 40 | 27 | 27 | 0 | | |
| | | | USB/Ethe | | | | | | |

Connect buttons as follows to the Renegade's GPIO...

Operational Instructions

Plug a USB flash drive into the system and connect the system to power. It will boot-up and when finished booting the red power LED will turn off. When that happens the system is ready to start recording. The boot process takes about 44 seconds.

Press the start/stop record button to start recording, which is the button connected to green wire. Once recording has started the red power LED will turn on. Press the start/stop record button will stop recording. When recording has stopped the green LED will turn on, indicating the system is transferring the recorded video to USB flash drive. When the red and green LEDs have turned off that indicates the file copy process is complete and the system is ready to start recording again. If the system reaches 90% RAM disk full the recording will stop on its own and the transfer process will execute.

To toggle frame rate between 30fps and 60fps, press the associated button, which is the button connected to yellow wire. The green LED will blink once to indicate 30fps mode and twice to indicate 60fps mode.

To toggle recording audio or not from the onboard mic, press the associated button, which is the button connected to the red wire. The green LED will blink once to indicate audio recording is disabled and twice to indicate recording of audio is enabled. If no mic is connected or detected the LED will only blink once, indicating that audio recording is disabled.

To power the system off, press the power off button, which is the button connected to the blue wire. When the system has been powered off the USB flash drive can then be removed. Do not remove the USB flash drive while the system is running. Doing so will prevent footage from being saved for that boot session.

If the system encounters any errors the green LED alone will turn on solid.

To power the system off you can press the power button or you can press the frame rate change and mic enable/disable button at the same time. The red and green LED lights will alternate blink several times and then will turn solid, whereby the system will then shutdown, with the LEDs turning off when the system shuts down.

If the system seems to have problems copying recorded videos from memory to USB flash drive the battery might need to be fully recharged.

The recording rate of 60fps with audio is about 17.7MB/s. Another sample: 1m 30s was 1.58GB

Updates (Nov. 23, 2023)

The system seems to have problems writing the video file to a USB flash drive for sustained periods. At around 1000 frames recorded frames start dropping badly. A solution is to create a mount point for a RAM drive, at /mnt/ramdrive, and then create the 1.5GB RAM drive at start-up. Then, the video file is to get moved to USB flash drive after recording is complete. The move process can take some time. The power LED is used to indicate when the copy process is in progress.

Disabling the green LED for a session to reuse it in the program...

Run:

echo none | sudo tee /sys/class/leds/green/trigger

It can then be turned on and off with...

```
echo 1 | sudo tee /sys/class/leds/green/brightness
echo 0 | sudo tee /sys/class/leds/green/brightness
```

Needed Improvements:

☑ Boot time is currently 1m 11s. Cut that down by disabling SSH and waiting for DHCP? Improved to 47s by disabling SSH and waiting for network at boot. Improved to 44s by changing GRUB timeout to 0. 44s might be the best possible without getting super invasive.

☑ Tidy-up cabling for the camera and power cord.

☑ Add and test a tiny USB microphone.

□ Implement a customizable audio delay. Delay in seconds would reside in a text file called delay.txt on the USB flash drive and would be loaded at program start, if the text file exists, and injected into the audio record command. With the USB mic a 0.25s delay for the audio is needed.

☑ Add a piezo speaker for audio feedback of booting complete, starting of recording, stopping of recording, and shutting down.

☑ Possibly improve transfer times to the USB flash drive using a tiny, two port USB 3.0 hub? Would need to make sure that doesn't negatively affect the camera. I tried adding a USB 3.0 hub, still keeping the RAM disk as recording target, and move times are certainly improved, at a tradeoff of more cable clutter.

☑ Work on a better indicator for shutdown sequence?

At the moment LEDs are off during the shutdown sequence. The red LED ever so slightly flickers on and off at the very end of the shutdown sequence. Making that more pronounced would be good. Pressing the mic enable/disable and frame rate selector buttons at the same time will trigger shutdown and will alternate the red and green LEDs for a moment, indicating shutdown procedure triggered.

☑ Automatically stop recording when /mnt/ramdisk is almost out of space? Done. Records until it detects 90%+ space used on /mnt/ramdrive, then it does the equivalent of pressing the stop button, which will move the recorded file to the USB flash drive.

 \Box Add a HDMI screen?

It would be nice to be able to frame shots, though I'm not sure if that would be easily possible, and if possible, if that would impact potential for dropped frames.

 \Box Add a tiny OLED display?

It would be nice to have a tiny OLED display to communicate more verbose status to the operator. Alas, the red and green LEDs are decently handy and fairly easy to work with in the C program.

FFmpeg Command for Anaglyph 3D Conversion:

ffmpeg -i input.mkv -vf "stereo3d=sbsl:arbg" output.mkv

Video Post Processing Considerations

Videos captured with this equipment are compressed with MJPEG. MJPEG isn't a very efficient codec with respect to more modern codecs, such as WebM VP9 and WebM AV1, A 1.33GB MJPEG video was re-compressed to a 202MB WebM VP9 video with 100 quality. Recompressing will lower the quality, but it seems essential to do so as MJPEG files are rather large from no intraframe compression, and they play poorly on VR headsets. It's possible that some light JPEG artifact removal could be beneficial to both image quality and compression. Other considerations include the notion of frame interpolation from 30 fps to 60 fps, or possibly even 60fps to 120fps. Image stabilization might also be desirable, though it would need to be done such that footage isn't recompressed twice. Converting the MJPEG footage to an intermediary, lossless format to then apply light artifact removal and image stabilization would be best, then re-compressing to a distribution format that's efficiently compressed for viewing. WebM seems desirable in that it can be viewed streamed to a web browser, whereas videos contained in MKV need to be downloaded first and then viewed. Further testing is needed to determine efficient workflows. It should be interesting to see what capabilities Magix VEGAS Pro 21 has for processing 180° 3D SBS footage, both in terms of artifact removal and image stabilization.

Basic Workflow Option 1

Take the raw MJPEG MKV footage and sync-up the audio if needed with separately recorded stereo audio file.

Render the audio as a WAV file.

Optionally run Flowframes on the MKV, rendering it to 60fps or 120fps, selecting WebM VP9 codec with quality level 15.

Mux the outputted video file (named video.webm for this example) with the WAV (named audio.wav for this example), also encoding the WAV as a FLAC, using this FFmpeg command...

ffmpeg -i video.webm -i audio.wav -c:v copy -c:a libvorbis output.webm

Basic Workflow Option 2

Open the raw MJPEG MKV footage in Kdenlive and sync-up separately recorded stereo audio file if needed.

Optionally run Flowframes on the MKV, rendering it to 60fps or 120fps, selecting AVI HUFFYUV codec (will generate a very large, intermediate video file).

Render the video file as a WebM AV1 video with desired quality settings.

Delete the intermediary video file.

Basic Workflow Option 3

Open the raw MJPEG MKV footage in Kdenlive, sync-up separately recorded stereo audio(s) file if needed, and edit the footage.

Render that video to a HUFFYUV video file.

Optionally run Flowframes on the HUFFYUV file, rendering it to 60fps or 120fps, selecting AVI HUFFYUV codec.

Render the video file as a WebM AV1 video with desired quality settings using <u>NotEnoughAV1Encodes</u> (portable version preferred).

Delete the intermediary video files.

Hosting Content Locally

Easily viewing 3D videos locally on a VR headset capable of viewing 180° SBS 3D videos from a web browser can be desirable. A quick and easy way to do so is to set-up a Raspberry Pi or Libre Computer board (the Le Potato AML-S905X-CC seems like a nice, cheap option) to serve as a simple, LAMP-based web server running on a home network. That can easily be done as follows.

First, set-up the board with Raspberry Pi OS / Raspbian or some other Debian Linux distribution. Set it up with username "user" and a password.

Run the following commands...

```
sudo apt update && sudo apt upgrade -y
sudo raspi-config
```

Enable SSH in raspi-config and then run additional commands...

```
sudo apt install apache2 -y
sudo chown -R user:user /var/www/html
mv /var/www/html/index.html /var/www/html/index2.html
hostname -i
```

That last command will indicate the IP address of the system. If you browse to that IP address you should see an index of the files in /var/www/html on the system. You can then use a SFTP client, such as <u>WinSCP</u>, to connect to the system by IP address and upload videos to /var/www/html and then browse to that site from your headset to either stream videos or download them for offline viewing.

Research Links

https://hub.libre.computer/t/how-to-control-gpio-on-renegade/1610 https://hub.libre.computer/t/turn-off-board-leds/2330 https://libre.computer/products/roc-rk3328-cc/ https://docs.google.com/spreadsheets/d/1H7Kxuy75X20WfsouZ6rKcEY4EYrFEdzDHxduTVSMAVo https://linuxgizmos.com/files/pine64_rock64_detail.jpg https://hub.libre.computer/t/roc-rk3328-cc-wake-on-interrupt-alternative/716/4 https://www.reddit.com/r/AV1/comments/s1b17o/comment/itwz2fc/ https://randomnerdtutorials.com/raspberry-pi-apache-mysql-php-lamp-server/ https://superuser.com/questions/982342/in-ffmpeg-how-to-delay-only-the-audio-of-a-mp4-video-without-converting-the-au

Core Components

- USB Web Camera, 4MP, Dual Lens USB Camera Module Synchronization (\$91.50) https://www.amazon.com/dp/B0CGXW6ZZK
- Libre Computer ROC-RK3328-CC (Renegade) Mini Computer, 4GB version (\$45) <u>https://www.amazon.com/dp/B078RT6H8X</u>

Up Down Angled USB 2.0 Type-A Male to USB-C Type-C Male (\$8.99) https://www.amazon.com/dp/B095LSPK25

Right Angle USB Cable, 6 Inches, 90 Degree USB to Micro USB Cable (\$8.49) https://www.amazon.com/dp/B00S8GU03A

microSDHC Memory Card (\$9.87)

https://www.amazon.com/PNY-Elite-microSDHC-Memory-P-SDU32GU185GW-GE/dp/B07R8GVGN9

Mini USB 2.0 Microphone Mic (\$6.99)

https://www.amazon.com/dp/B0138HETXU

64GB USB 3.1 Flash Drive (\$8.99)

https://www.amazon.com/gp/product/B01LFV52Y6

5000mAh USB Power Bank (\$6.97) or 10000mAh USB Power Bank (\$22.97)

https://www.homedepot.com/p/Tzumi-5000-mAh-Slim-Pro-Pocket-Juice-Portable-Power-Bank-6583HD/313232332 https://www.homedepot.com/p/Tzumi-10-000-mAh-Slim-Pro-Pocket-Juice-Portable-Power-Bank-7526HD/313232419

Total: **\$186.80**

Additional Components and Tools

Tact Buttons

https://www.amazon.com/gp/product/B00W0YUV1W

DuPont Jumper Wires

https://www.amazon.com/gp/product/B081C89L1F

Prototyping PCB

https://www.amazon.com/gp/product/B0166GCD42

3" x 3/4" Zinc Corner Brace

https://www.menards.com/main/hardware/utility-hardware/corner-flat-braces/national-hardware-reg-zinc-corner-brace-4-count/n113-456/p-144448898837-c-9700.htm?exp=false

Soldering Station

https://www.amazon.com/gp/product/B000AS28UC

Solder Smoke Absorber

https://www.amazon.com/gp/product/B07VWDN29F

Helping Hands

https://www.amazon.com/gp/product/B083SFWLW7

Solder (Lead-Free)

https://www.amazon.com/gp/product/B01M071WEE

Rosin Paste Flux

https://www.amazon.com/gp/product/B008ZIV85A

Soldering Iron Tip Cleaner

https://www.amazon.com/gp/product/B00FZPGDLA

Cordless Drill

https://www.homedepot.com/p/RYOBI-ONE-18V-Cordless-3-8-in-Drill-Driver-Kit-with-1-5-Ah-Battery-and-Charger-PDD209K/312462410

Drill Bits

https://www.amazon.com/MACXCOIP-Hardened-Stainless-Plastics-Storage/dp/B0BDKR2KFZ

Precision Screwdriver Set

https://www.amazon.com/gp/product/B099K2QG9T

#6-¾" Pan Head Phillips Screws

https://www.homedepot.com/p/Everbilt-6-x-3-4-in-Phillips-Pan-Head-Stainless-Steel-Sheet-Metal-Screw-7-Pack-800991/204275396

- #10-3/4" Flat Head Phillips Wood Screws (optional, as the corner brace come with screws) https://www.homedepot.com/p/Everbilt-10-x-3-4-in-Phillips-Flat-Head-Zinc-Plated-Wood-Screw-12-Pack-807491/204275574
- 1/4 in.-20 x 1/2 in. Combo Round Head Zinc Plated Machine Screw https://www.homedepot.com/p/Everbilt-1-4-in-20-x-1-2-in-Combo-Round-Head-Zinc-Plated-Machine-Screw-5-Pack-803461/204274641

Zip Ties

 $\underline{https://www.homedepot.com/p/Commercial-Electric-4-in-and-8-in-Cable-Tie-Tube-200-Pack-4in-8in-natural-black-200/203531950$

Rubber Washers

https://www.amazon.com/gp/product/B0B6TWG5HQ

M2 Screws and Nuts

https://www.amazon.com/gp/product/B01K6N6O7S

1⁄4"-20 T-Nut

https://www.amazon.com/gp/product/B091DH7D4W

Cheap Multimeter (for checking continuity of the buttons)

https://www.amazon.com/UT30D-Pocket-size-Multimeter-Generator-Sinometer/dp/B005TLXNPO

Zeadio Video Action Stabilizing Handle Grip Handheld Stabilizer (optional) https://www.amazon.com/dp/B00LKK99QA

Piezo Speaker (optional)

https://www.amazon.com/SynHHergyx-Motherboard-Computer-Speakers-Internal/dp/B0DHZQ485W

3D Printer (for printing 3D parts)

Laser Printer (for printing paper pilot hole templates)